CLAIMS

What is claimed is:

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1. An instrument for detecting one or more superstrates, comprising:

a transmission line;

a substrate mounted on an opposite side of said transmission line from said one or more superstrates;

a plurality of measurement cells formed within said transmission line;

a microwave source for applying a microwave signal to said transmission line and each of said plurality of measurement cells formed within said transmission line; and

a detector for detecting said one or more superstrates with respect to said plurality of measurement cells.

2. The instrument of Claim 1, wherein said transmission line further comprises a coplanar waveguide with a center conductor mounted between two outer conductors.

3. The instrument of Claim 2, wherein said center conductor is mounted so as to define first and second spaces between said center conductor and each of said two outer conductors, said first and second spaces each having a width smaller than about one hundredth of an inch.

4. The instrument of Claim 3, wherein said first and second spaces are equal in width.

5. The instrument of Claim 3, wherein said center conductor is mounted so as to define first and second spaces between said center conductor and each of said two outer conductors, said first and second spaces each having a width such that an electric field is affected by said one or more superstrates having a thickness of less than two millimeters.

6. The instrument of Claim 1, wherein said substrate has a thickness of less than one tenth inch.

7. The instrument of Claim 1, wherein said substrate has a dielectric constant less than five.

8. The instrument of Claim 1, further comprising a coaxial cable connected to said transmission line with a gold ribbon connection.

9. The instrument of Claim 1, further comprising:

each of said plurality of measurement cells being spaced apart along said transmission line with respect to each other.

10. The instrument of Claim 1, further comprising:

a known superstrate for covering a plurality of non-measurement portions of said transmission line not including said measurement cells.

11. The instrument of Claim 10, wherein each of said plurality of non-measurement portions of said transmission line have a length equal to an effective wavelength of said microwave signal divided by two.

12. The instrument of Claim 1, further comprising a plurality of non-measurement portions of said transmission line, at least a portion of said measurement cells being physically partitioned from said plurality of non-measurement portions of said transmission line.

13. The instrument of Claim 1, further comprising a plurality of non-measurement portions of said transmission line, at least a portion of said measurement cells being non-physically partitioned from said plurality of non-measurement portions of said transmission line.

14. The instrument of Claim 1, further comprising:

a plurality of transmission lines, a plurality of measurement cells formed on each of said plurality of transmission lines, and a mulitplexor for switching between said plurality of transmission lines.

15. The instrument of Claim 1, wherein at least one of said one or more superstrates is formed of a porous material.

16. The instrument of Claim 1, wherein at least a portion of said substrate is formed of a porous material.

17. The instrument of Claim 1, wherein said transmission line is uniform along its length without discontinuities.

18. The instrument of Claim 1, further comprising:

a plurality of discontinuities formed within said transmission line.

19. The instrument of Claim 18, wherein said plurality of discontinuities further comprise a plurality of stubs extending from said transmission line.

20. The instrument of Claim 19, wherein said plurality of stubs form said plurality of measurement cells.

21. The instrument of Claim 19, wherein said plurality of stubs form markers between said plurality of measurement cells.

22. The instrument of Claim 18, wherein said plurality of discontinuities further comprises a plurality of power dividers.

23. The instrument of Claim 1, further comprising:

a second transmission line, said second transmission line being configured to produce a detected signal more sensitive to a thickness of said one or more superstrates than said first transmission line.

24. The instrument of Claim 1, wherein said transmission line is configured to provide a signal to said detector that is substantially unaffected by a thickness of said one or more superstrates.

25. A waveguide sensor for detecting one or more superstrates, comprising:

a center conductor;

two outer conductors mounted such that said center conductor is disposed between said two outer conductors such that a respective spacing is formed on either side said center conductor separating said center conductor from said two outer conductors, each said respective spacing being selected for controlling a measurement depth of said superstrate, said center conductor and said two outer conductors being oriented parallel with respect to each other; and

a substrate mounted on an opposite side of said waveguide sensor from said superstrate.

26. The waveguide sensor of Claim 25, wherein each of said respective spacings are less than one-hundreth of an inch.

27. The waveguide sensor of Claim 25, wherein each of said respective spacings are selected for detecting a superstrate less than two millimeters thick.

28. The waveguide sensor of Claim 25, wherein said substrate has a dielectric constant less than about five.

29. The waveguide sensor of Claim 25, wherein said substrate has a thickness less than about one-tenth of an inch.

30. The waveguide sensor of Claim 25, wherein at least a portion of said substrate is porous.

31. The waveguide sensor of Claim 25, further comprising:

a plurality of measurement cells disposed along said center conductor and said two outer conductors.

32. The waveguide sensor of Claim 31, further comprising:

a plurality of non-measurement portions disposed along said center conductor and said two outer conductors, at least a portion of said plurality of measurement cells being physically partitioned from said plurality of non-measurement portions.

33. The waveguide sensor of Claim 31, further comprising:

a plurality of non-measurement portions disposed along said center conductor and said two outer conductors, at least a portion of said measurement cells being non-physically partitioned from said plurality of non-measurement portions.

34. The waveguide sensor of Claim 31, further comprising:

a plurality of non-measurement portions disposed along said center conductor and said two outer conductors, a microwave source for applying a microwave signal to each of said plurality of measurement cells, said non-measurement portions having a length of a wavelength of said microwave signal divided by two, and a known superstrate covering said center conductor for said plurality of non-measurement portions.

35. The waveguide sensor of Claim 25, wherein each said respective spacing is equal to each other.

36. The waveguide sensor of Claim 25, further comprising:

a second waveguide for determining a thickness of said superstrate, said second waveguide having a single elongate conductive strip, a conductive ground plane, and a second substrate separating said elongate conductive strip and said conductive ground plane.

37. A waveguide sensor for detecting one or more superstrates, comprising:

a single elongate conductive strip;

a conductive ground plane; and

a substrate mounted on an opposite side of said one or more superstrates, said substrate separating said single elongate conductive strip and said conductive ground plane.

38. The waveguide sensor of Claim 37, further comprising:

said substrate being selected for sensing a thickness of said superstrate up to about

one inch, and

a second waveguide, said second waveguide comprising a center conductor and two outer conductors mounted such that said center conductor is disposed between said two outer conductors forming a space on either side of said center conductor, said spacing being selected such that a signal produced by said second waveguide is substantially insensitive to said thickness of said superstrate.

39. The waveguide sensor of Claim 37, wherein said substrate has a thickness in the range of from 0.075 inches to 0.150 inches.

40. The waveguide sensor of Claim 37, wherein said substrate has a dielectric constant less than about five.

41. The waveguide sensor of Claim 37, wherein at least a portion of said substrate is porous.

42. The waveguide sensor of Claim 37, further comprising:

a plurality of measurement cells disposed along said single conductive strip.

43. The waveguide sensor of Claim 42, further comprising:

a plurality of non-measurement portions disposed along said single conductive strip, at least a portion of said measurement cells being physically partitioned from said plurality of non-measurement portions.

44. The waveguide sensor of Claim 42, further comprising:

a plurality of non-measurement portions disposed along said elongate conductive strip, at least a portion of said measurement cells being non-physically partitioned from said plurality of non-measurement portions.

45. The waveguide sensor of Claim 42, further comprising:

a plurality of non-measurement portions disposed along said single conductive strip, a microwave source for applying a microwave signal to each of said plurality of measurement cells, at least a portion of said non-measurement portions having a length of a wavelength of said microwave signal divided by two, and a known superstrate covering said plurality of non-measurement portions.

46. A computer simulation for predicting results of a simulated superstrate detector, said simulated superstrate detector having a transmission line with a plurality of sensors along said transmission line, said computer simulation comprising:

a first input for a transmission line substrate thickness;

a second input for a transmission line substrate dielectric constant;

a third input for producing a change related to a simulated superstrate;

a fourth input for an operating frequency; and

an output for said simulated superstrate detector.

47. The computer simulation of Claim 46, wherein said third input relates to temperature change for said simulated superstrate.

48. The computer simulation of Claim 47, further comprising:

an input for starting temperature.

49. The computer simulation of Claim 46, further comprising:

an input for changes in temperature.

50. The computer simulation of Claim 46, wherein possible superstrates to be detected are defined.

51. The computer simulation of Claim 50, wherein possible superstrates are limited to air, water, ice, glycol and mixtures of water, ice, and glycol.

52. The computer simulation of Claim 46, further comprising:

a fifth input for a size of each of said plurality of sensors.

53. A method of detecting one or more superstrates on a transmission line, comprising:

providing a plurality of measurement cells within said transmission line;

applying a signal to said transmission line such that said signal is applied to each of said measurement cells;

measuring an output signal from said transmission line for said detection of said one or more superstrates.

54. The method of Claim 53, further comprising:

measuring a phase of said output signal.

55. The method of Claim 53, further comprising:

measuring a phase and amplitude of said output signal.

56. The method of Claim 53, further comprising:

providing a plurality of transmission lines wherein each of said plurality of transmission lines contains a plurality of measurement cells.

57. The method of Claim 56, further comprising:

providing a mulitiplexor to separately sample a respective output signal from each of said plurality of transmission lines.

58. The method of Claim 56, further comprising:

utilizing said plurality of transmission lines to determine a position of said one or more superstrates.

59. The method of Claim 58, further comprising:

positioning said plurality of measurement cells on each of said plurality of transmission lines to enhance said determining of said position of said one or more superstrates.

60. The method of Claim 59, further comprising:

staggering a first of said plurality of measurement cells on a first of said plurality of transmission lines with respect to a second of said plurality of measurement cells on a second of said plurality of transmission lines.

61. The method of Claim 58, further comprising:

providing different lengths for said plurality of transmission lines.

62. The method of Claim 56, further comprising:

utilizing different frequencies on said plurality of transmission lines.

63. The method of Claim 56, further comprising:

utilizing a first transmission line for detecting a presence of one or more superstrates, and

utilizing a second transmission line for detecting a thickness of said one or more superstrates when said presence is detected.

64. The method of Claim 53, further comprising:

collecting data with a data acquisition board.

65. The method of Claim 53, wherein said signal is a microwave signal.

66. A method of determining a respective complex constant associated with one or more superstrates positioned along a waveguide at a plurality of measurement positions, said method comprising:

applying a plurality of frequencies to said waveguide;

measuring an amplitude and phase for each of said plurality of frequencies to produce an observed data vector; and

estimating a complex constant for said one or more measurement positions to produce an estimated data vector.

67. The method of Claim 66, further comprising:

providing that characteristic impedance and propagation constants of said waveguide are known when said wave guide is covered by said one or more superstrates.

68. The method of Claim 66, further comprising:

comparing said observed data vector with said estimated data vector to produce a difference data vector.

69. The method of Claim 66, further comprising:

reiterating said steps of estimating and comparing until said difference data vector approaches zero; and

determining a final estimated complex constant for each of said one or more superstrates.

70. The method of Claim 66, further comprising:

constraining values of said estimated complex constant for each of said one or more measurement positions to discrete values associated with one or more anticipated superstrates.

71. The method of Claim 66, further comprising;

comparing a change of said observed data vector with a known rate of change.

72. The method of Claim 71, wherein said known rate of change is from water to ice.

73. The method of Claim 71, wherein said known rate change is from ice to air due to a strong wind event.

74. The method of Claim 69, further comprising:

when said complex constant for each of said one or more measurement positions are slowly changing then optimizing said method using said final estimated complex constant for each of said one or more superstrates as a first iteration estimated complex constant for each of said one or more superstrates.

75. The method of Claim 66, wherein said step of estimating further comprises estimating a complex dielectric constant for each of said one or more measurement positions to produce said estimated data vector.

76. An ice detector operable for use on a surface that may be covered with ice, said ice detector comprising:

one or more elongate transmission lines greater than ten feet long, said one or more transmission line having a thickness less than about one-tenth of an inch so as to substantially conform to said surface;

one or more metallic covered measuring cells along said one or more elongate transmission lines;

a microwave signal source for exciting said one or more elongate transmission

lines;

a detector for receiving a signal from said one or more elongate transmission lines; and

a processor for processing said signal from said one or more elongate transmission lines.

77. The ice detector of Claim 76, further comprising:

a plurality of said measuring cells and a plurality of non-measuring cells forming said one or more elongate transmission lines.

78. The ice detector of Claim 77, wherein said microwave frequency may be varied for changing a relative electrical spacing of said plurality of said measuring cells and said plurality of said non-measuring cells.

79. The ice detector of Claim 76, wherein said microwave signal source produces a plurality of frequencies.

80. The ice detector of Claim 76, wherein said processor obtains a time domain response by a Fourier transform of said signal.

81. The ice detector of Claim 77, wherein said plurality of non-measuring cells are metallic covered.